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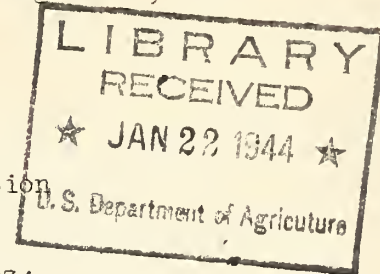
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## THE EROSION PROBLEM IN LAND USE

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Since the beginning of the Emergency Conservation program, inaugurated by President Roosevelt and commonly referred to as the reforestation program, much publicity has been given the subject of erosion. One of the principal jobs upon which the Civilian Conservation Corps is at work in the nation's forest areas is erosion control.

Broadly speaking, there are two kinds of soil erosion: normal or geologic erosion; and abnormal or accelerated erosion.

The first may be described as that slow wearing down of the land which, by the action of glaciers, water, wind and gravity, has carved the mountains through geologic ages into their present forms, and, by the transportation and deposition of the loosened rock particles, has built up the land upon which the farms and cities of today are built. This normal erosion, operating for the most part so slowly that it can scarcely be observed, may be regarded as a beneficent process, since it tends to renew the fertile land from which man draws his sustenance. The rate at which this process goes on varies with topography, precipitation, vegetation, and the texture of the soil, and in each locality normal erosion is the resultant of these climatic and physiographic factors. In regions well covered with vegetation, whether forest or brush, the normal erosion is too small to be observed. In semi-arid regions where the vegetative cover is much lighter, as in the chaparral sections of California, it is still sufficient to restrain erosion to negligible rates.

On the other hand, when these natural balances are upset, the erosion process is likely to be greatly increased, and the second or abnormal form of erosion is the result. Observers in the Department of Agriculture have for years emphasized the fact that the destructive erosion which is active in many sections of the country is due chiefly to man's mistreatment of the soil or of its natural vegetative cover. It is this man-caused or man-accelerated erosion upon which we shall focus our attention this evening.

Measured by its economic consequences, agricultural malpractice has unquestionably been the leading cause of destructive erosion in the United States. The Director of the new Soil Erosion Service states that man's agricultural and livestock operations have increased the erosion rate on 75 per cent of all land cultivated in the United States, and that the impoverishment of grazing-land by soil washing, is affecting between



75 and 90 per cent of western range lands. By far the greater part of this damage is done in the form of sheet erosion which removes the top-soil, bit by bit, wherever the vegetation is open enough to permit its movement by water.

As the topography becomes steeper, particularly in rolling or foothill lands, erosion takes the form of gullying, which operates more rapidly and far more conspicuously than sheet erosion. At least 17 million acres of formerly cultivated land in the United States have been abandoned on that account in the past twenty years. In his report for 1934 the Secretary of Agriculture states: "Unrestrained soil erosion is rapidly building a wilderness of worn-out lands in the United States. One hundred million acres of land now in crop have lost all or most of the top-soil; farmers operating on this denuded land are sub-soil farmers, practicing bankrupt farming on bankrupt land whose productivity has been vastly reduced."

Agricultural erosion has been under investigation by the government during the past fifteen years, and there are now established ten regional experiment stations for the sole purpose of studying this great problem. Already numerous corrective methods have been developed, but a vast amount of research still waits to be done to reduce erosion to safe and economic limits.

For much of the abandoned hill land, particularly that in the Piedmont Plateau there can be no possibility of restoring the land to profitable farming. The only hope of checking the continuing erosion process is to cover such land as rapidly as possible with trees and permit it to remain permanently in forest cover. Methods for accomplishing this have been successfully developed by the Forest Service and were put into practice on a large scale during the past year by workers of the Civilian Conservation Corps.

The recent dust storm in the midwest was an example of wind erosion on an enormous scale. The dust of this storm was top-soil lifted from a vast acreage of plowed prairie land which, previous to cultivation, has been protected for untold centuries by a natural mantle of perennial grasses. Here was an instance of land misuse on a large scale - the attempt to cultivate field crops, against great odds, on land qualified by nature for range use only.

The great shelter-belt of trees to be planted in this region is merely a palliative, a costly corrective measure designed to alleviate in some degree the damage done by civilized man during the brief years of his occupancy. In spite of the many ultimate benefits which will result from the shelter-belt, wind erosion in that region will doubtless continue during periods of drought, so long as man continues to expose the soil by cultivation. Probably the final solution over much of the wind-affected region will be to restore the area, in whole or in part, to grass cover.

With this picture of conditions in other parts of the country in mind, the question may well be asked: "How do we stand in California?" As a loyal Californian, I should like to be able to state that our use of





the land has been so careful as to have precluded accelerated erosion. Unfortunately, such a statement would not be true. We do have erosion, accelerated, in places, to an alarming degree and traceable directly to some abuse of the land or of its forest cover. Moreover, the seriousness of our case is augmented by the fact that the erosion process in California is intimately bound up with our problem of water supply.

With 80 per cent of the effective precipitation in the State occurring during 5 months in winter and spring, proper conservation of our water requires elaborate storage and distribution systems. Storage is accomplished by reservoirs and by sinking the water into the porous gravel deposits in the valleys. Since both these methods require clear water for their continued functioning, erosion, loading the streams with silt, is a constant threat to water storage.

Because of this close relation between erosion and water supply in California, I shall confine the remainder of this talk to erosion in mountain areas. Agricultural erosion in the valleys is quite another story, and a serious one.

In general, our mountains are well protected with forest cover in a wide variety of types, but in all of these cover types, the chief destructive agency is fire, followed by overgrazing, bad logging methods and road building.

The Forest Service in California is studying, under experimental control, how the burning off of forest cover affects runoff and erosion. In these experiments, large tanks of soil at Berkeley, and numerous plots one-fortieth acre in size in the mountains, were employed, some with the natural litter and forest cover intact and some deliberately burned bare. These studies have shown that vegetation not only retards runoff by obstruction on the soil surface, but also, through the action of leaf-litter and roots, keeps the top-soil porous so that a large proportion of rain-water percolates continuously into the soil to join underground supplies. Percolation into litter-covered soil was found to average 5 to 10 times that into bare burned soil; while runoff was just the reverse, being 10 to 30 times as great from bare soil as from litter-covered soil. Erosion volumes were generally 100 to 1000 times greater from fire-denuded plots than from forest-covered ones, and the rate of erosion increased greatly with the increase in rainfall intensity.

These facts help to explain why gentle rains, if well distributed through the season, cause little or no damage on newly burned areas, while heavy rains, with an intensity of one inch or more per hour, quickly puddle the surface soil, seal the soil pores, and start a rapid process of gully erosion. When this stage is reached during a heavy storm, the excess water rushes down the barren slopes, gathering up soil and rock fragments in ever-increasing size and volume until it reaches the bed of the stream. There the accumulated flow is soon swelled to a raging torrent, which sweeps everything before it, scouring the channel, snapping trees from their roots, plucking huge boulders from deep embeddings, and finally surging forth upon the valley floor in great destructive waves of mud, debris, and boulders. Some of my listeners have probably seen this extreme erosional process in operation during the past winter.





As to the amount of erosion in California, I shall describe only a few examples, and suggest that my listeners amplify the list by their own observation. It will be an enlightening experience.

Range erosion is probably at its worst in the foothills around the headwaters of the San Joaquin Valley. A few miles east and north of Bakersfield, systems of gullies are rapidly approaching the stage of badlands. Although the total annual rainfall of this region is small, rain, when it does come, may fall with torrential intensity. Originally, the naturally sparse vegetation of grass and herbs was sufficient to maintain the soil surface at normal rates of erosion. By depleting this scant protective cover, excessive grazing and the trampling of hungry stock have been directly responsible for starting the accelerated erosion which is now so far advanced.

Silting of reservoirs is exemplified by the Gibraltar Reservoir which supplies domestic water to the city of Santa Barbara. During the ten years since completion of this reservoir forest fires have swept approximately 75 per cent of its watershed area. Erosion, caused by heavy rains following these fires, has resulted in deposition of sediment in the reservoir to the extent of 14 per cent of its storage capacity. Should this rate of deposition continue, the reservoir would be completely filled in another 60 years. In the same watershed the smaller Juncal reservoir, supplying the city of Montecito, is similarly threatened with extinction.

Control of erosion in this watershed by the use of check-dams has not been found satisfactory. The Forest Service, in cooperation with local agencies, has developed the more promising method of securing a quick cover-crop of vegetation on the burned areas by the broadcast sowing of mustard seed, the purpose being to protect the soil until the chaparral is reestablished. Results secured during the past two years indicate that the method fully justifies its cost of 90 cents to \$1.30 per acre, and plans are now under way for the sowing of an additional 20,000 acres of these burned watersheds.

In the Sacramento Valley, north of Redding, lies a denuded and heavily eroded area which is one of the outstanding examples of land abuse in the State. Between 1905 and 1925 sulphur dioxide fumes from ore smelters killed the pine and oak forest on a hundred square miles of mountain land. Today that denuded area is still a barren waste, dissected by great gullies which contribute annually to the Sacramento River many thousands of tons of choking silt. Most of this land is privately owned, but recent experiments on public domain lands in the area have shown that restoration of forest cover is possible by the planting of native willow in the gullies and pine seed on the slopes. This is a costly process and, even with success, it will probably be a hundred years before a timber crop may be ready for harvesting from the planted lands. In contemplating the enormous silting of the Sacramento River, the cost of dredging its lower reaches to keep it navigable, and the loss of timber production through all these years, one may well question whether the few million dollars worth of metals that were recovered by the smelting have justified the attendant damages. Fortunately, these



particular smelters are now dismantled, and any future operations of smelters in the State are compelled by law to provide modern safeguards against the escape of deadly fumes.

In southern California the tragic flood of last New Year's eve, in the Crescenta-Canada Valley, gave spectacular evidence of the extreme erosion which is possible in fire-denuded watersheds. In this instance a forest fire in late November destroyed the chaparral cover on 4800 acres of the south slope of the San Gabriel Mountains. At the foot of these slopes a number of residential suburbs had been developed during the past twenty years. During all that time no serious floods had occurred, and a false sense of security possessed the people living on land which had been built up by erosion deposits of past floods. When, on December 30, the big three-day storm began, the stage was set for disaster. More than 12 inches of rain fell within 50 hours on the steep denuded slopes. Runoff of flood proportions resulted, and erosion occurred at an enormous rate. Flood streams of mud and boulders swept through the towns in waves of destruction. Surveys made after the flood showed nearly 700,000 cubic yards of debris deposited in the towns and on the valley floor. Erosion from the burned area had reached the astounding rate of 50,000 cubic yards per square mile.

In striking contrast, measurements of the same storm on unburned watersheds in the San Dimas Experimental Forest east of the burn, showed erosion at the rate of only 42 cubic yards per square mile. Such quantities can scarcely be detected in the streams and are completely negligible. The Arroyo Seco watershed, adjacent to the burned area but untouched by the fire, showed no signs of erosion, and the runoff waters, even at high stage, ran clear and caused no damage. Similar results were observed in other well-forested canyons within the storm track, which extended eastward for 25 miles.

These storm results, apart from the deplorable loss of life and destruction of homes, have given convincing proof of the protective function of a forest cover - even so lowly a forest as the much-maligned chaparral of southern California. Officials in charge of flood control in that part of the State are unanimous in declaring that a good cover of native vegetation on the mountain sides is their first line of defense against destructive floods and erosion. Forest and water authorities are increasing their vigilance, to prevent fires and to improve the methods of suppressing fires which may start in spite of all precaution. It appears certain that no reasonable expense will be spared to protect California's valuable watershed areas. But no amount of improvement in methods of fire-fighting or of erosion control can do as much toward preventing erosion and safeguarding our precious water supplies, as the whole-hearted cooperation of the public in preventing forest fires.

From even this brief discussion it is evident that destructive soil erosion is nation-wide, and that the process is equally active on private and public lands. In every part of the country we have exploited the soil as though it were inexhaustible. Whether by unwise cultivation which is so insidious, by the burning of our forests which is so spectacular, or by overgrazing, destructive lumbering and ill-considered road



building - much of our land use has been misused. Through ignorance and carelessness we have been building a great domain of wasteland which is not only unproductive in itself but which, uncontrolled, is spreading its blighting effects to adjoining lands.

We have passed the pioneer stage in America when no one dared to question the right of the individual to do as he pleased with his own property. Today this ancient right of laissez faire must yield to the more civilized principle that no one of us may do that which if done by all would bring ruin to society. Applied to the problem of erosion in land use, this means that all use of the land, whether public or private, must submit to intelligent regulation, not only to prevent immediate and obvious damage but to conserve and safeguard that most basic natural resource of the nation - the soil itself.

